FIG. 1

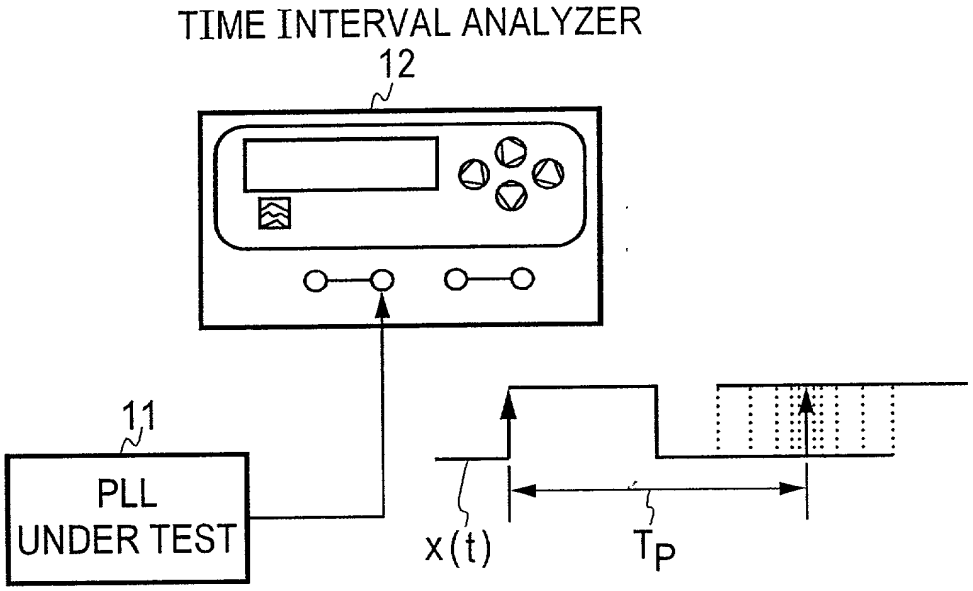

TIME INTERVAL ANALYZER
12
11
PLL
UNDER TEST
x(t)
T_P

FIG. 2

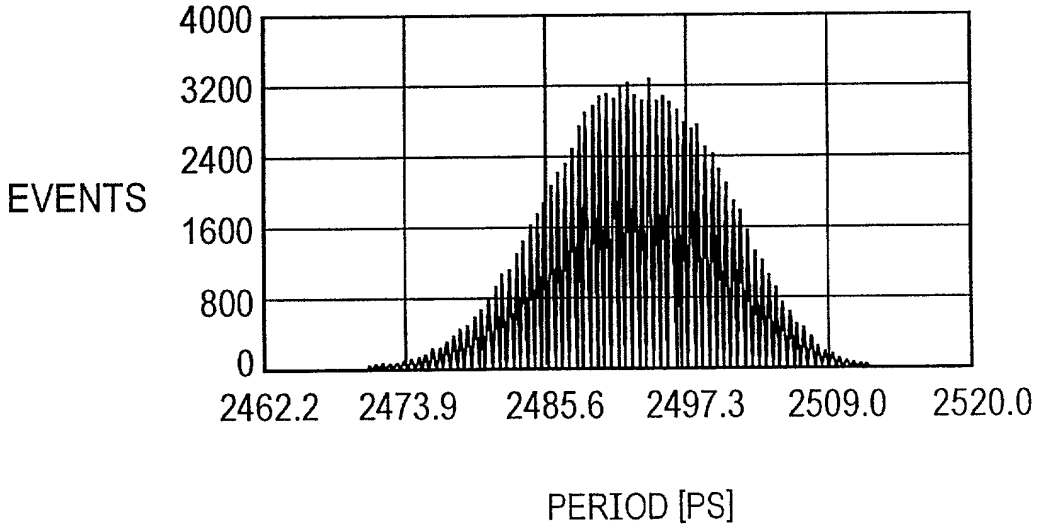

EVENTS
4000
3200
2400
1600
800
0
2462.2
2473.9
2485.6
2497.3
2509.0
2520.0
PERIOD [PS]

FIG. 3

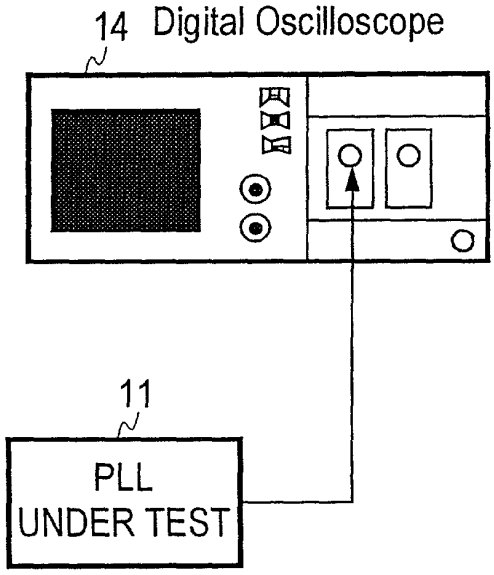

14 Digital Oscilloscope
11
PLL
UNDER TEST

FIG. 4

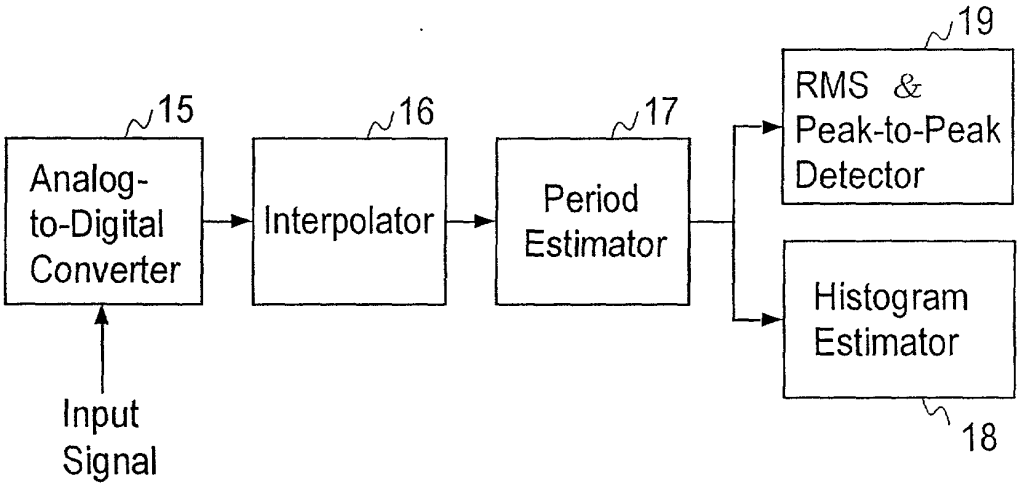

15
Analog-
to-Digital
Converter
16
Interpolator
17
Period
Estimator
19
RMS &
Peak-to-Peak
Detector
Histogram
Estimator
18
Input
Signal

FIG. 5A

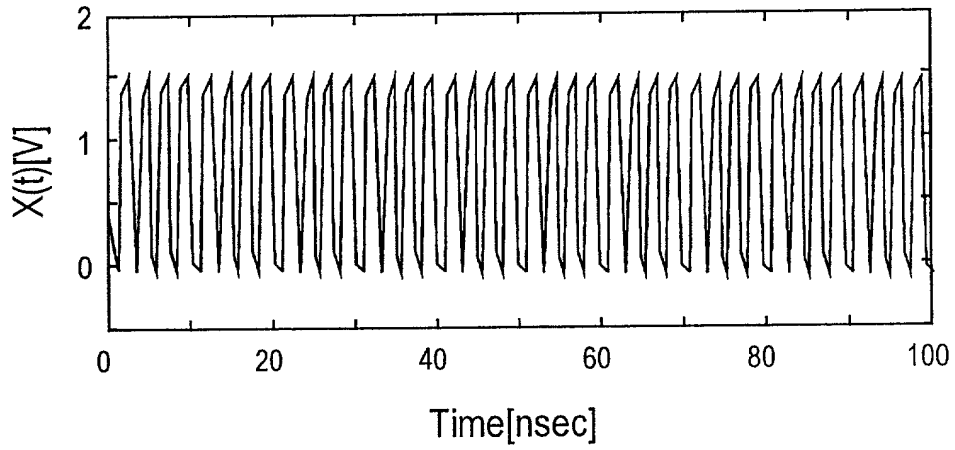
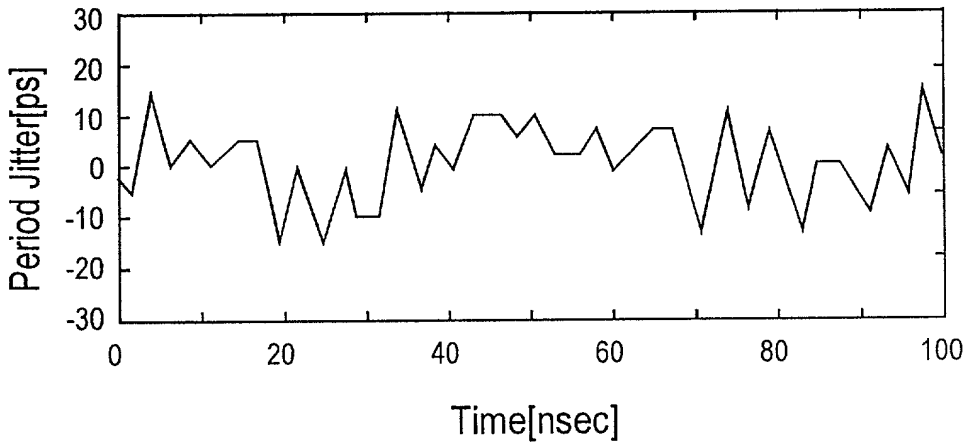

2
1
0
X(t)[V]
0
20
40
60
80
100
Time[nsec]

FIG. 5B


30
20
10
0
-10
-20
-30
Period Jitter[ps]
0
20
40
60
80
100
Time[nsec]

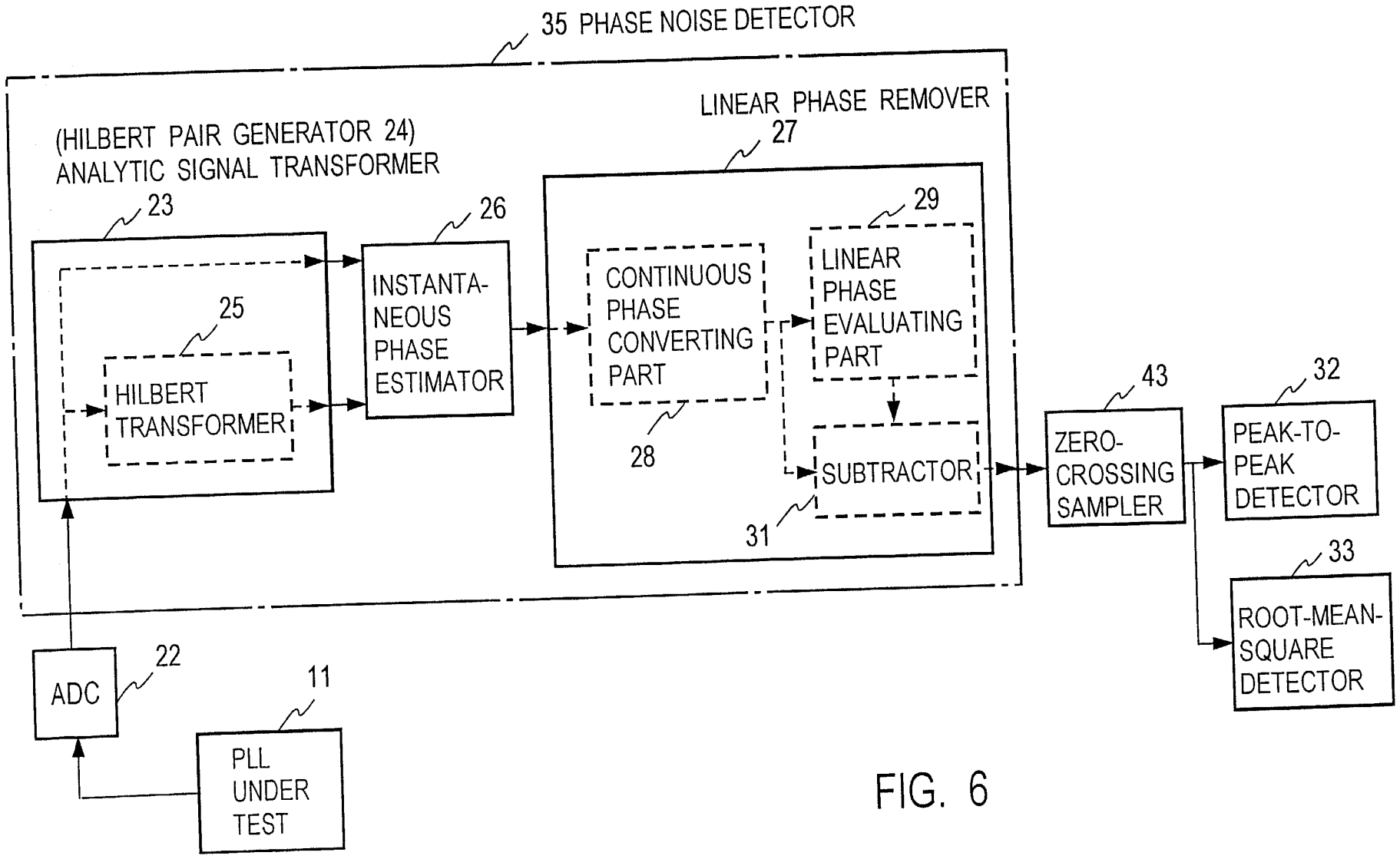

35 PHASE NOISE DETECTOR
(HILBERT PAIR GENERATOR 24)
ANALYTIC SIGNAL TRANSFORMER
23
25
HILBERT TRANSFORMER
26
INSTANTA-NEOUS PHASE ESTIMATOR
LINEAR PHASE REMOVER
27
CONTINUOUS PHASE CONVERTING PART
28
29
LINEAR PHASE EVALUATING PART
SUBTRACTOR
31
43
ZERO-CROSSING SAMPLER
32
PEAK-TO-PEAK DETECTOR
33
ROOT-MEAN-SQUARE DETECTOR
ADC
22
11
PLL UNDER TEST

FIG. 6

FIG. 7

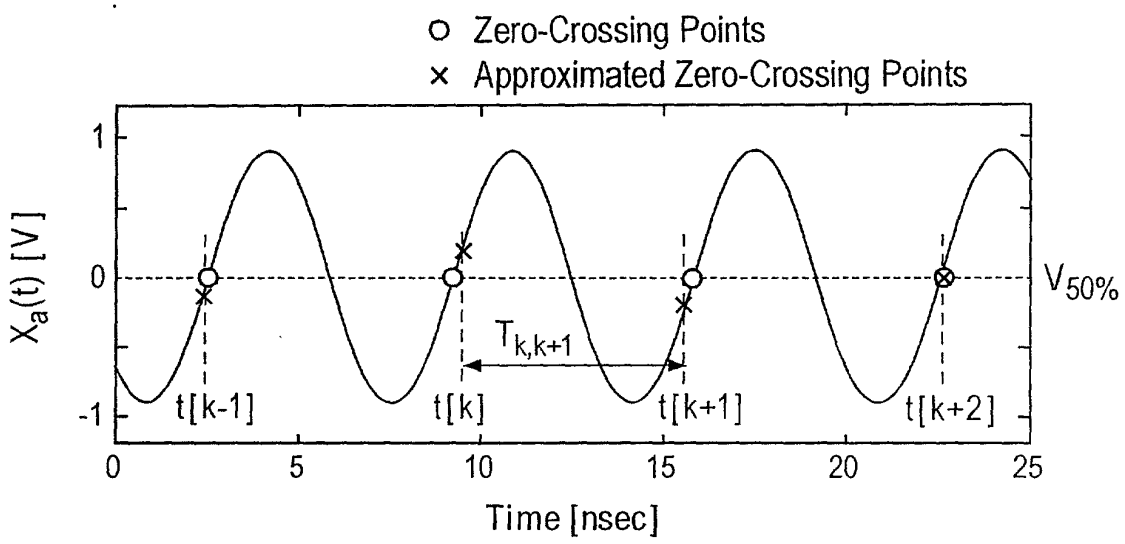


FIG. 8

Method	No. of Events	J_{RMS}	J_{PP}
$\Delta\phi$ Method	23,255	2.4534 ps (+0.5%)	8.0029 ps (+15.9%)
Corrected $\Delta\phi$ Method	23,255	2.4404 ps (-0.004%)	8.0029 ps (+0.04%)
Ideal Value	--	2.4405 ps	6.9028 ps

FIG. 9A

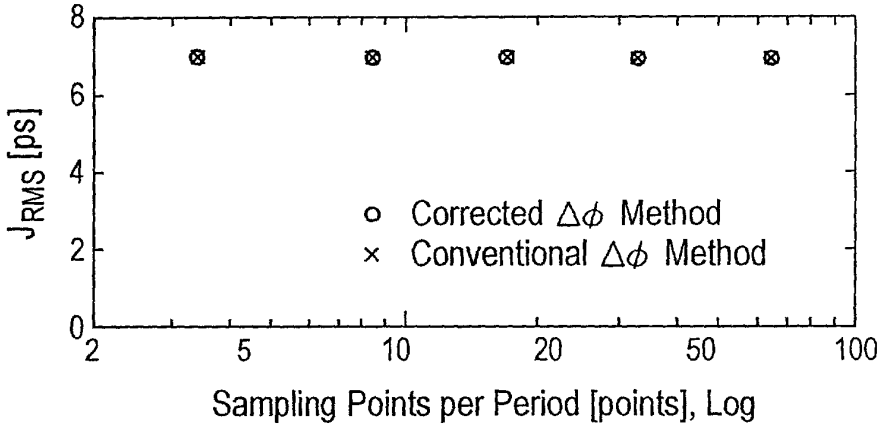

8
6
4
2
0
J_{RMS} [ps]
Corrected Δφ Method
Conventional Δφ Method
2
5
10
20
50
100
Sampling Points per Period [points], Log

FIG. 9B

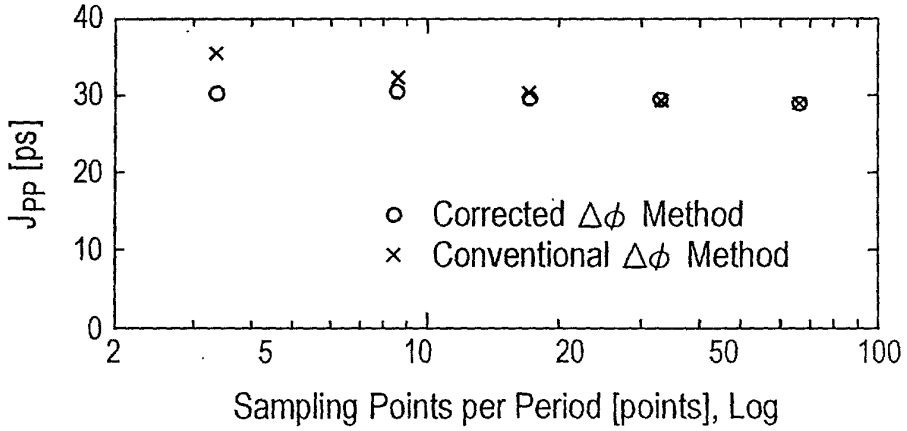

40
30
20
10
0
J_{PP} [ps]
Corrected Δφ Method
Conventional Δφ Method
2
5
10
20
50
100
Sampling Points per Period [points], Log

FIG. 10A

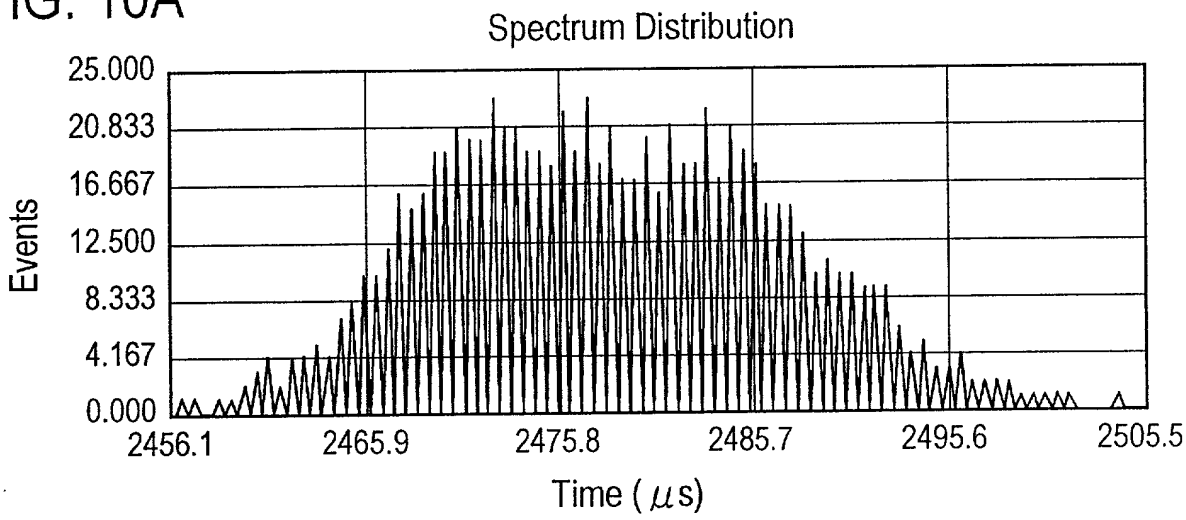


FIG. 10B

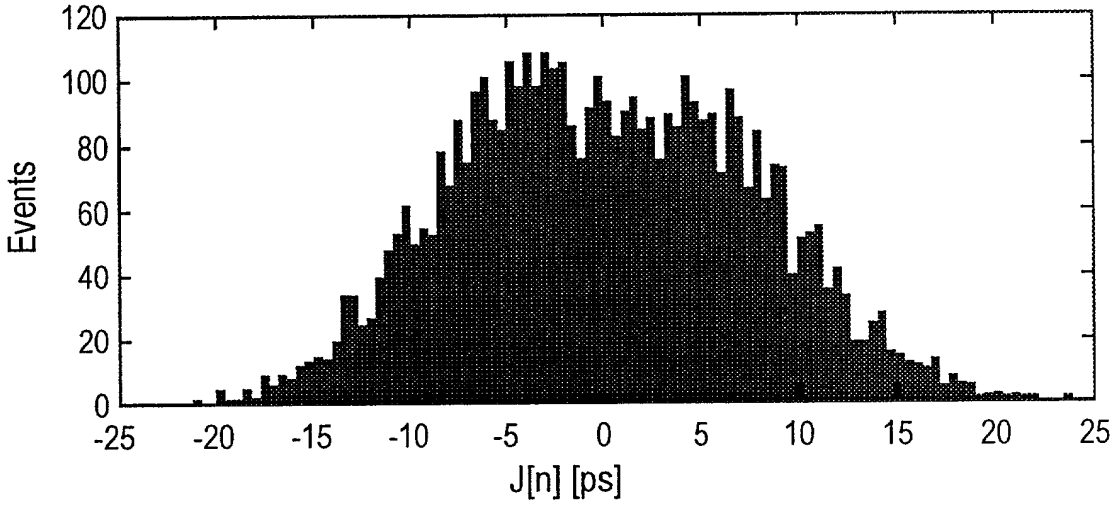


FIG. 11

Method	No. of Events	J_{RMS}	J_{PP}
Time Interval Analyzer	10,000	7.72 ps	48.2 ps
Corrected $\Delta\phi$ Method	4,696	7.48 ps	45.2 ps
Difference	-53%	-3.1%	+0.4%

FIG. 12

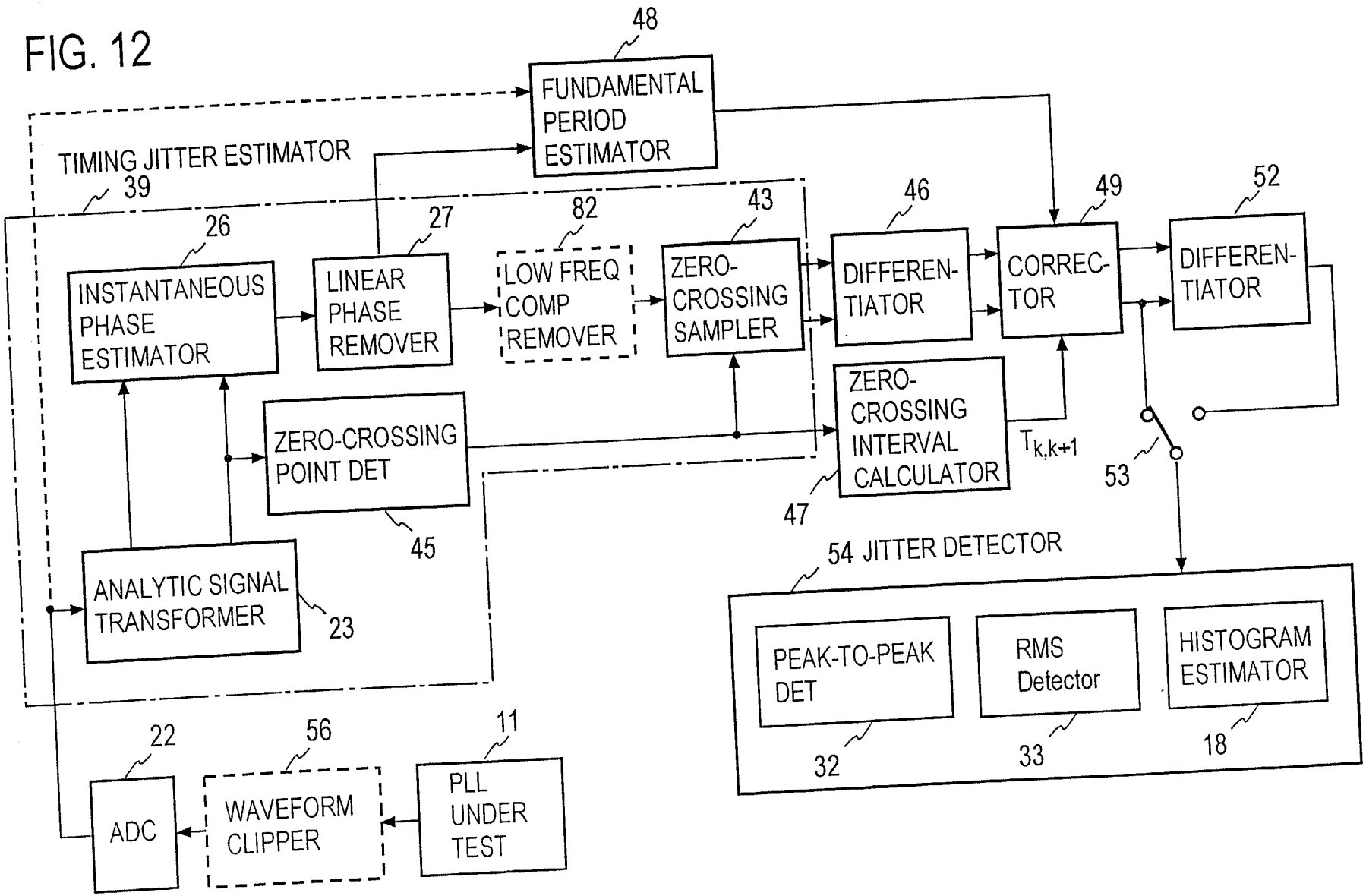

48
FUNDAMENTAL PERIOD ESTIMATOR
TIMING JITTER ESTIMATOR
39
26
INSTANTANEOUS PHASE ESTIMATOR
27
LINEAR PHASE REMOVER
82
LOW FREQ COMP REMOVER
43
ZERO-CROSSING SAMPLER
46
DIFFEREN-TIATOR
49
CORREC-TOR
52
DIFFEREN-TIATOR
ZERO-CROSSING POINT DET
45
ZERO-CROSSING INTERVAL CALCULATOR
47
$T_{k,k+1}$
53
ANALYTIC SIGNAL TRANSFORMER
23
54 JITTER DETECTOR
PEAK-TO-PEAK DET
32
RMS Detector
33
HISTOGRAM ESTIMATOR
18
22
ADC
56
WAVEFORM CLIPPER
11
PLL UNDER TEST

FIG. 13

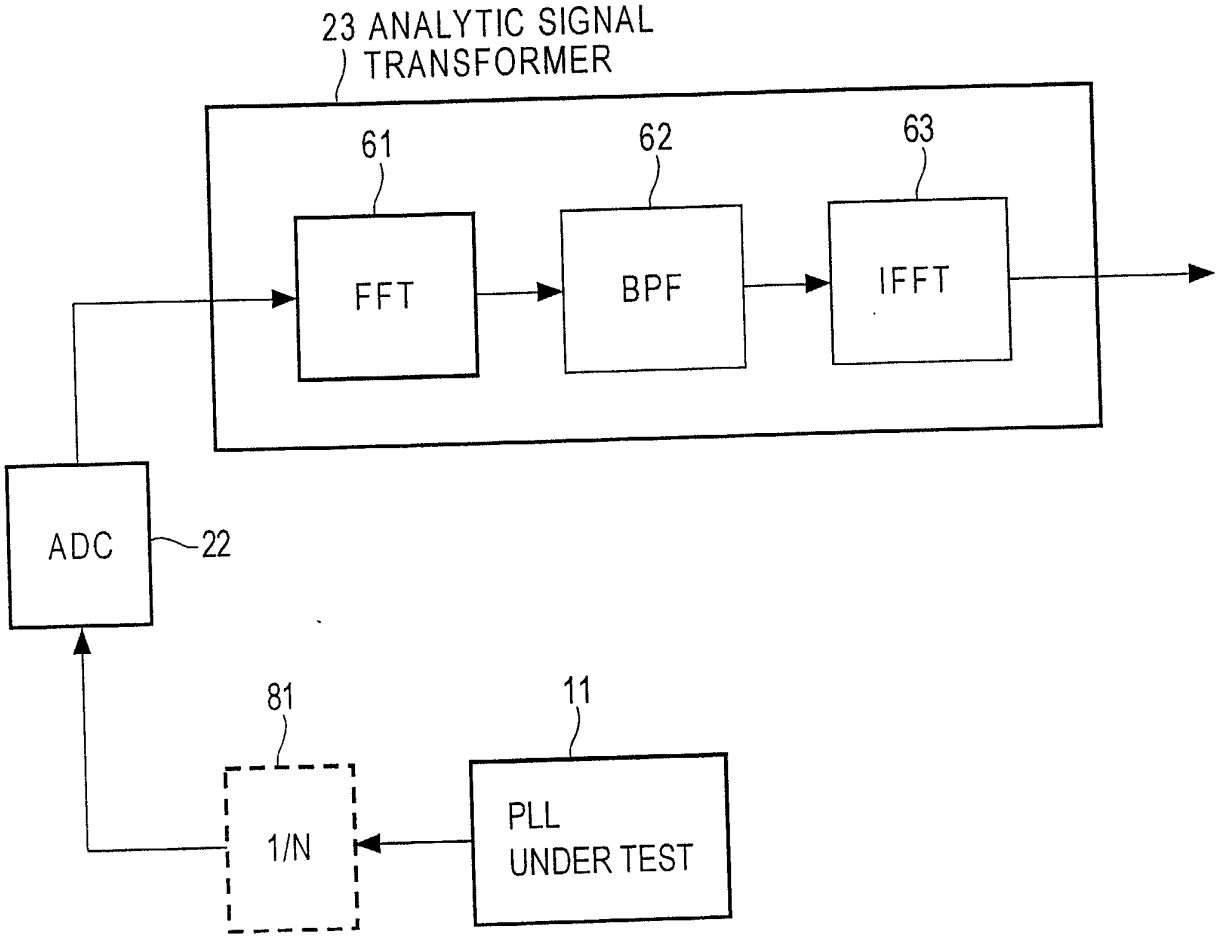

23 ANALYTIC SIGNAL TRANSFORMER
61
62
63
FFT
BPF
IFFT
ADC
22
81
11
1/N
PLL UNDER TEST

FIG. 14

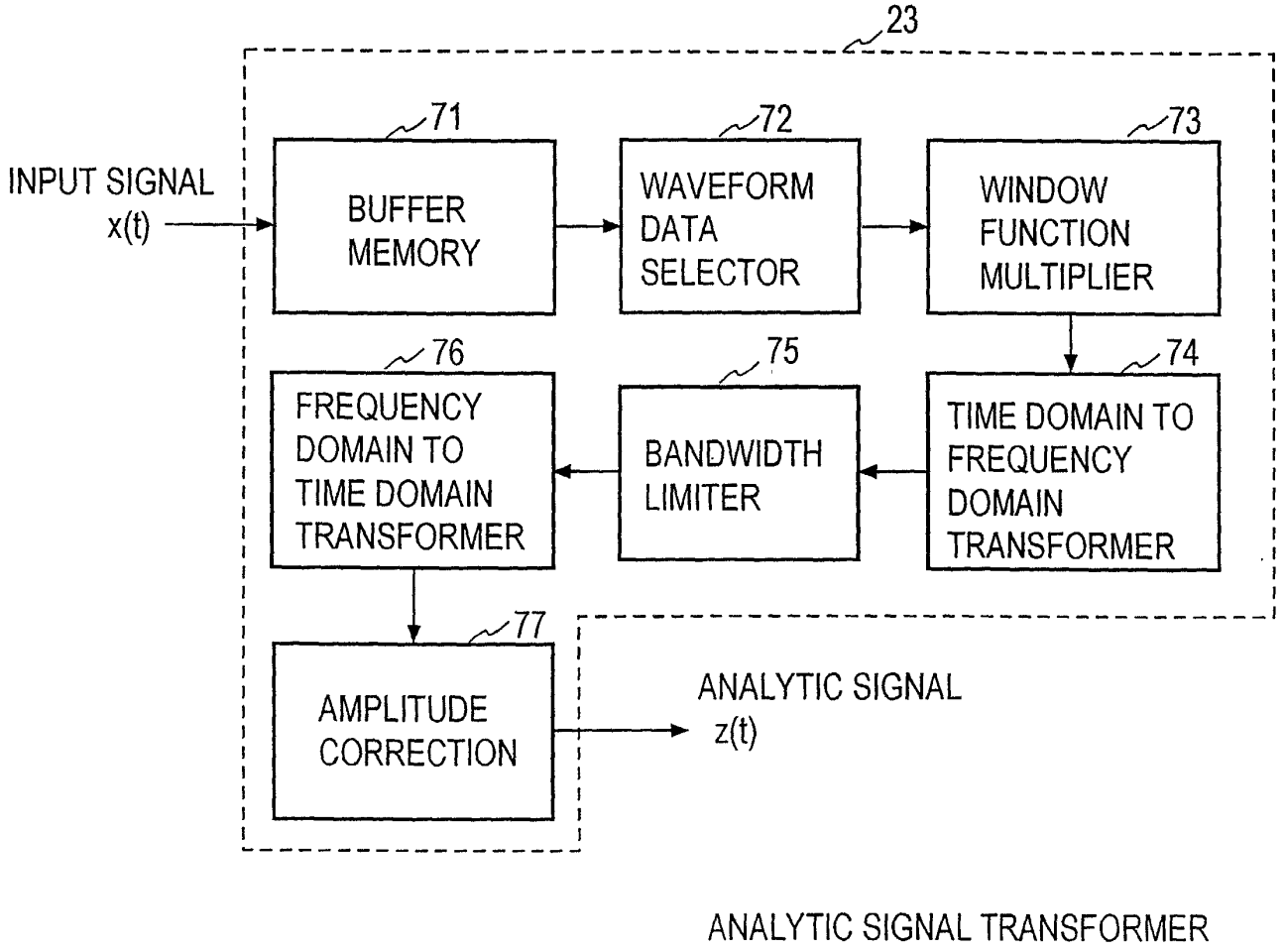

23
71
72
73
INPUT SIGNAL
x(t)
BUFFER MEMORY
WAVEFORM DATA SELECTOR
WINDOW FUNCTION MULTIPLIER
76
75
74
FREQUENCY DOMAIN TO TIME DOMAIN TRANSFORMER
BANDWIDTH LIMITER
TIME DOMAIN TO FREQUENCY DOMAIN TRANSFORMER
77
AMPLITUDE CORRECTION
ANALYTIC SIGNAL
z(t)
ANALYTIC SIGNAL TRANSFORMER

FIG. 15

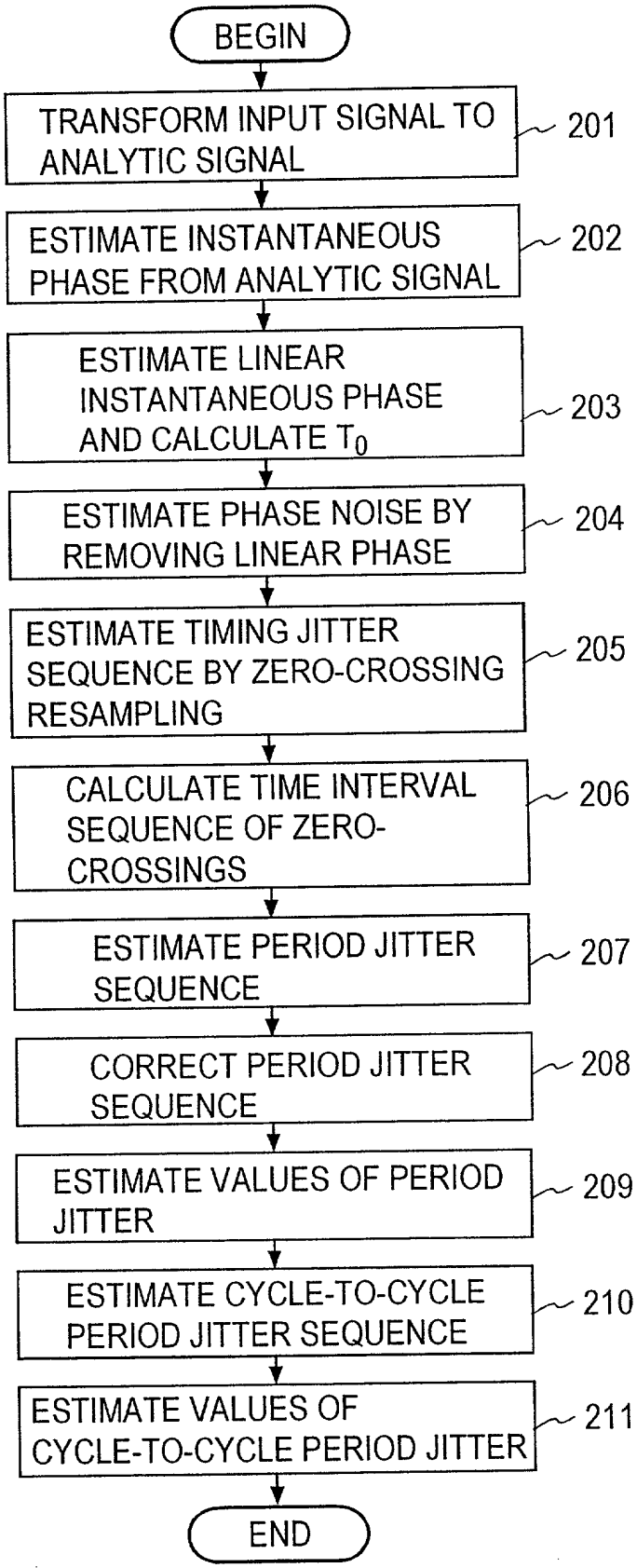

BEGIN
TRANSFORM INPUT SIGNAL TO ANALYTIC SIGNAL
201
ESTIMATE INSTANTANEOUS PHASE FROM ANALYTIC SIGNAL
202
ESTIMATE LINEAR INSTANTANEOUS PHASE AND CALCULATE T_0
203
ESTIMATE PHASE NOISE BY REMOVING LINEAR PHASE
204
ESTIMATE TIMING JITTER SEQUENCE BY ZERO-CROSSING RESAMPLING
205
CALCULATE TIME INTERVAL SEQUENCE OF ZERO-CROSSINGS
206
ESTIMATE PERIOD JITTER SEQUENCE
207
CORRECT PERIOD JITTER SEQUENCE
208
ESTIMATE VALUES OF PERIOD JITTER
209
ESTIMATE CYCLE-TO-CYCLE PERIOD JITTER SEQUENCE
210
ESTIMATE VALUES OF CYCLE-TO-CYCLE PERIOD JITTER
211
END

FIG. 16

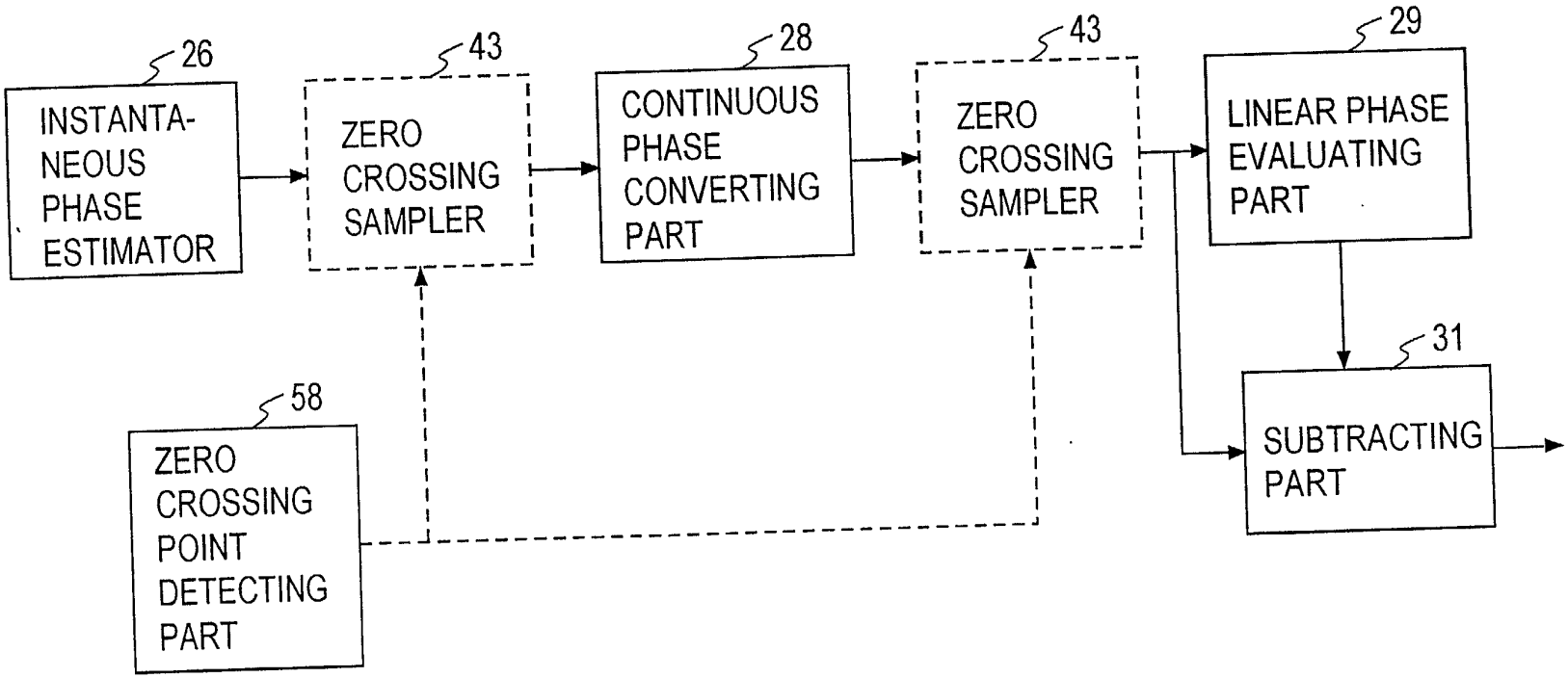
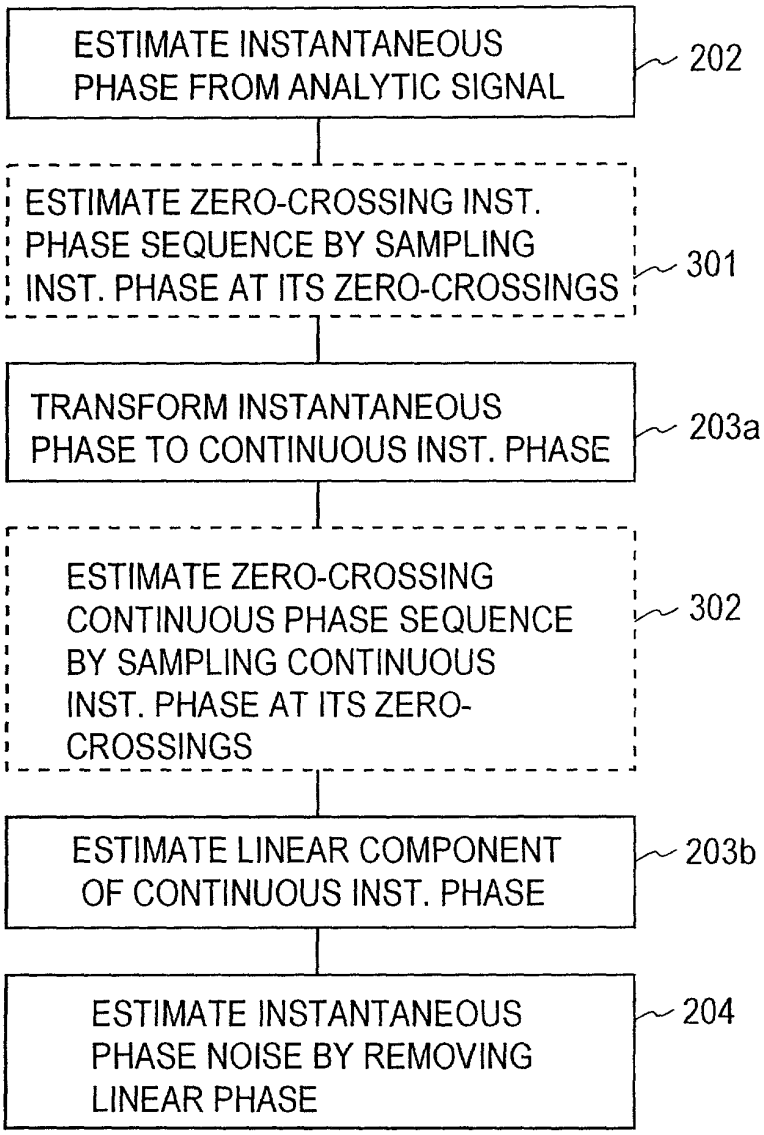

26
INSTANTA-
NEOUS
PHASE
ESTIMATOR
43
ZERO
CROSSING
SAMPLER
28
CONTINUOUS
PHASE
CONVERTING
PART
43
ZERO
CROSSING
SAMPLER
29
LINEAR PHASE
EVALUATING
PART
31
SUBTRACTING
PART
58
ZERO
CROSSING
POINT
DETECTING
PART

FIG. 17


ESTIMATE INSTANTANEOUS PHASE FROM ANALYTIC SIGNAL
202
ESTIMATE ZERO-CROSSING INST. PHASE SEQUENCE BY SAMPLING INST. PHASE AT ITS ZERO-CROSSINGS
301
TRANSFORM INSTANTANEOUS PHASE TO CONTINUOUS INST. PHASE
203a
ESTIMATE ZERO-CROSSING CONTINUOUS PHASE SEQUENCE BY SAMPLING CONTINUOUS INST. PHASE AT ITS ZERO-CROSSINGS
302
ESTIMATE LINEAR COMPONENT OF CONTINUOUS INST. PHASE
203b
ESTIMATE INSTANTANEOUS PHASE NOISE BY REMOVING LINEAR PHASE
204